Waves	Wave movement and phase difference

Learning objectives	MUST (C)	Examine displacement-distance graphs for waves at different points in the period
	SHOULD (B)	Be able to define phase difference
	COULD (A/A*)	Calculate phase differences in degrees and radians

STARTER: What do we mean by reflection and refraction? When can you see them in everyday life?

EXTENSION: When waves refract, they change speed.
Do they change wavelength? Or frequency? Or neither? Or both?

▶ 0:04:00

Refraction of an acoustic wave

λ_1 : wavelength in medium 1

θ_1

medium with high wave speed

λ_2 : wavelength in medium 2

θ_2

medium with low wave speed

isvr
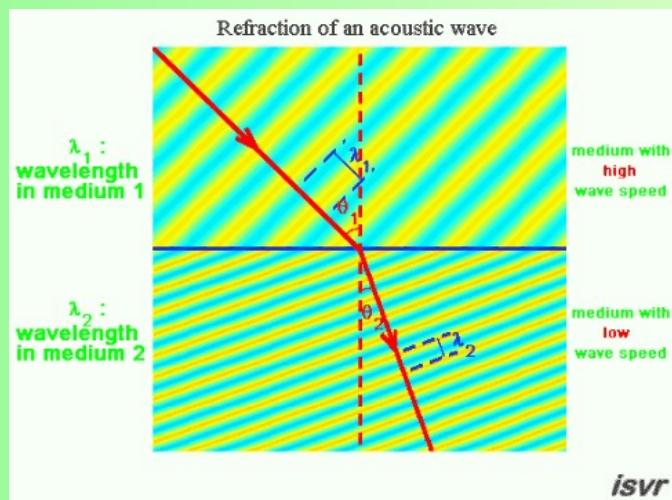
What changes?

Frequency stays the same:

wavelength changes

therefore, speed changes

Oct 16-21:59

Waves	**Wave movement and phase difference**

MUST (6)	Examine displacement-distance graphs for waves at different points in the period
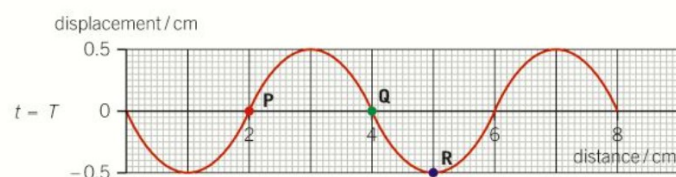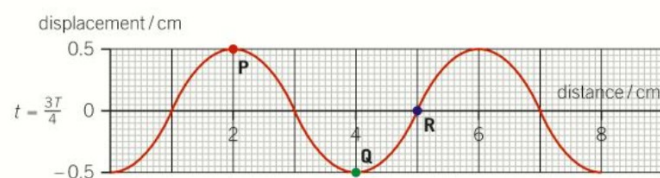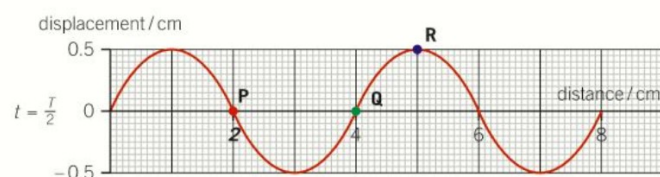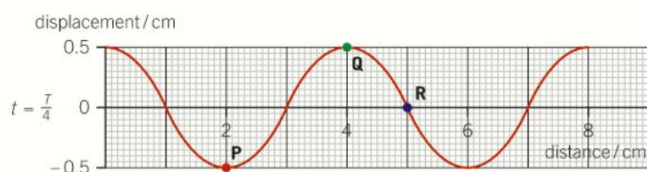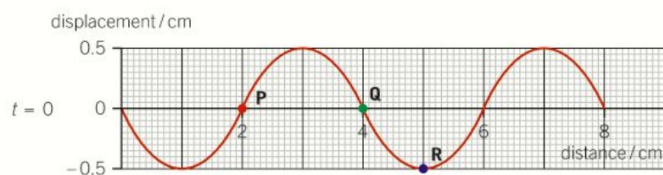
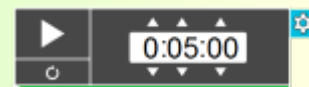What does this graph show? Would it look different for transverse/ longitudinal waves?

What will it look like after....

T/2?

T?

T/4?

3T/4?

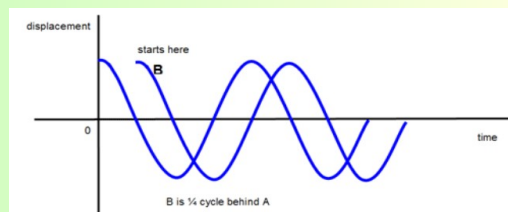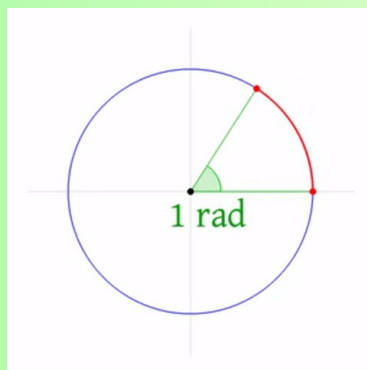
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Waves	Wave movement and phase difference

SHOULD (7)	Be able to define phase difference, phase and antiphase

Phase difference is the difference between the displacement of particles along a wave, or of displacements of particles on different waves.

1 complete cycle =

360° or 2π radians

If there is a phase difference of 0°, the movements at that point are aligned - they move the same amount in the same direction at the same time - and the points are **in phase**.

If there is a phase difference of 180°, the movements are always opposite - as one rises, the other falls - and the points are **in antiphase**. Note: 'out of phase' means **any** difference in phase, antiphase is very specific.

What other phase differences are 'in phase' or 'in antiphase'?

In phase: multiples of 360°, or multiples of 2π

In antiphase: (180° + n*360°, or odd multiples of π)

Oct 16-21:59

Waves	Wave movement and phase difference

COULD (8/9)	Calculate phase difference in degrees and radians

Phase difference φ (phi) of two points on a wave of wavelength λ, or between the same point on two waves, separated by a distance x:

$$\varphi = \frac{X}{\lambda} \times 360° \qquad \varphi = \frac{X}{\lambda} \times 2\pi$$
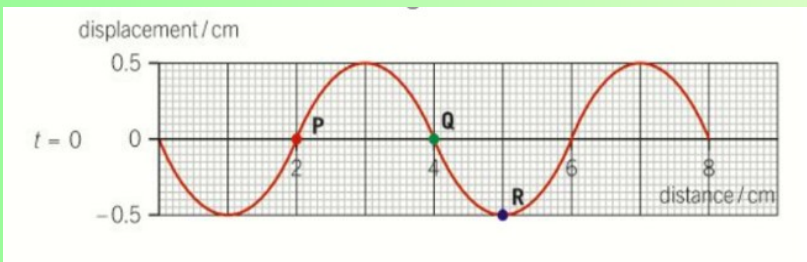
degrees   radians

Note: the distance x could be a difference in time. The calculation is exactly the same, but with the period instead of the wavelength.

Example for two points on same wave: phase difference between Q and R

Find an easily identifiable point (crest, equilibrium position...) that you can see on both waves. Also find the period using a wave or half-wave

Difference: 0.42 seconds

Period: 6 seconds

$$\varphi = \frac{X}{T} \times 360°$$

$$\varphi = \frac{0.42}{6} \times 360° \quad \varphi = 25.2°$$

Waves	Wave movement and phase difference

COULD (8/9) Calculate phase difference in degrees and radians

Use the same method for the other examples on the worksheet.

Your answer may not exactly match the one given below; it's not possible to see the exact values from the graph. Make your best approximation.

Image no.	Phase difference (°)
1	25.5
2	139.7
3	163.8
4	106.3
5	41.9
6	158.0

Oct 16-21:59

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PLENARY: Answer this question, with full working.

0:04:00
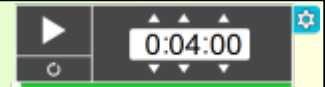
A wave of frequency 5 Hz travels at 8 km s^{-1} through a medium. What is the phase difference, in radians, between two points 2 km apart?

A   0

B $\dfrac{\pi}{2}$

C π

D $\dfrac{3\pi}{2}$

B

Jan 8-22:39